Energy & Sports Nutrition

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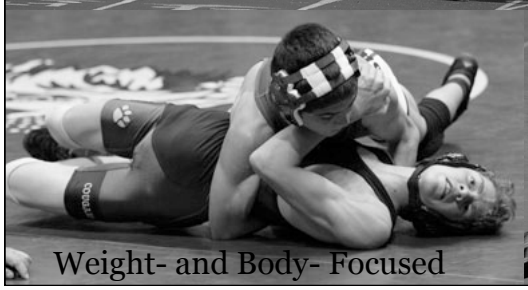
Energy for Sport

Very High Intensity

Endurance



Weight- and Body- Focused

Intermittent, High-Intensity

History of Sport Energy Research

- 1920

XXX. THE RELATIVE VALUE OF FAT AND CARBOHYDRATE AS SOURCES OF MUSCULAR ENERGY.

WITH APPENDICES ON THE CORRELATION BETWEEN STANDARD METABOLISM AND THE RESPIRATORY QUOTIENT DURING REST AND WORK.

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with the collaboration of
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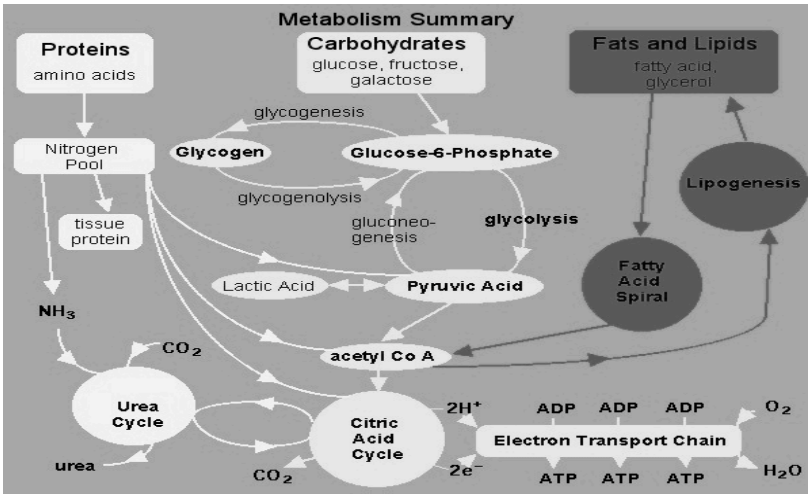
(*Received August 26th, 1919.*)

- 1960's and 1970's
  - Bergstrom ad Hultman "Supercompensation" and the effects of dietary CHO, FAT, PRO manipulation
- Current….

Energy Systems Overview



http://www.humpath.com/fatty-acid-oxidation-diseases

Energy Systems

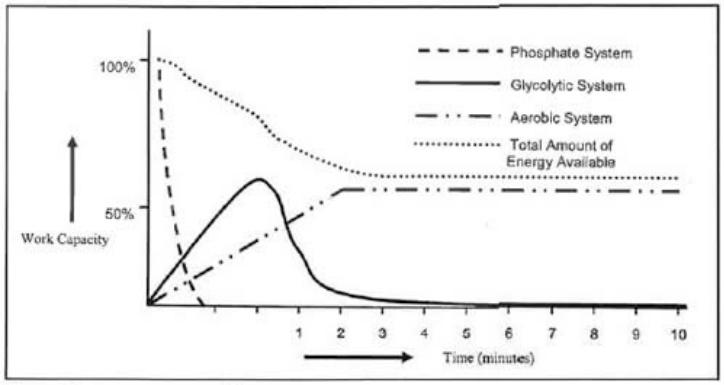


Figure 1: Energy systems activity as a function of time and capacity (adapted from Verheijen, 1998)

Wells, G. D., Selvadurai, H., & Tein, I. (2009). Bioenergetic provision of energy for muscular activity. *Paediatric Respiratory Reviews*, 10, 83-90.

High-Intensity, Short Duration Sports

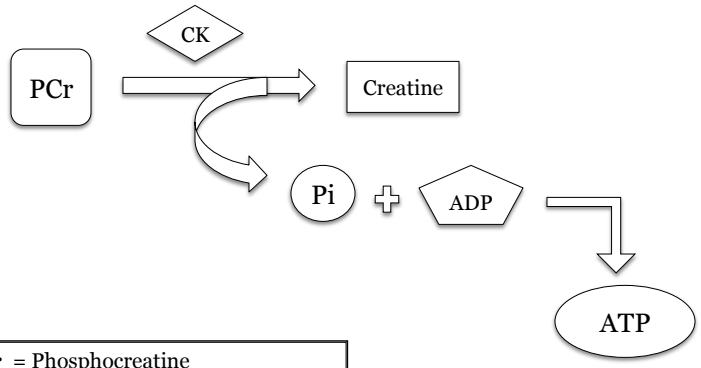
- Examples of Sport Activities:
  - run/swim/cycle sprints, jumps, discus throws, hurdles, pole-vaulting
  - Events lasting from seconds to minutes

- Primary energy systems:

1.High Energy Phosphate System (ATP-PC)
- (Up to 15 seconds)

2.Anaerobic Glycolysis System
- (15 seconds-3 minutes)

High-Energy Phosphate System



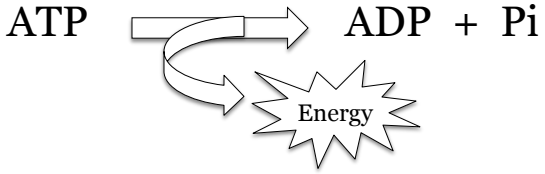
PCr = Phosphocreatine
CK = Creatine kinase
Pi = Inorganic Phosphate Molecule
ADP = Adenosine Diphosphate
ATP = Adenosine Triphosphate

High Energy Phosphate System

- Phosphocreatine (PCr) is the most rapidly accessible form of energy "storage."
- The reaction:
  1. Creatine kinase (CK) catalyzes the reaction
  2. Phosphocreatine (PCr) releases inorganic phosphate molecule (Pi)
  3. _____ combines with ADP to form ATP.
- ATP is used for energy

ATP and Energy

- How is energy produced from ATP?
  - Energy is released when ATP is broken through hydrolysis, forming ADP and an inorganic phosphate molecule (Pi).



  - The released energy is 9-10 kcals per mole of ATP.

Anaerobic Glycolysis System

- One molecule of glucose yields 2 ATP and 2 pyruvate
- With no oxygen (anaerobic pathway), the 2 pyruvate molecules convert into 2 lactate molecules

- Time frame: > 15 seconds until < 3 minutes
- Lactate production ⇧ as intensity of workout ⇧

Anaerobic Glycolysis

- 1 glucose yields 2 ATP

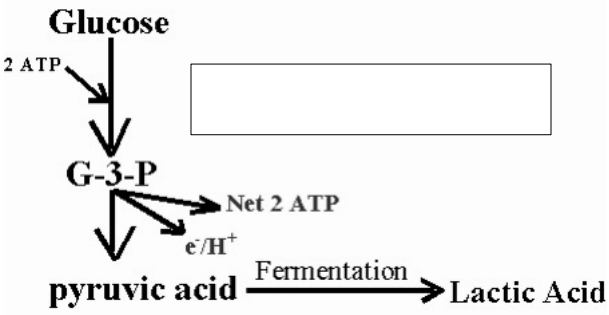


Illustration source: http://webanatomy.net/anatomy/glycolysis.jpg

Study: Energy System Contribution to 400-m and 800-m track running

- 400-m: 11 males, 5 females
- 800-m: 9 malmes, 2 females

- Lab-graded exercise tests; multiple race time-trials(simulated event treadmill running)

- Based on VO2, Accumulated Oxygen Deficit (AOD) measures, blood lactate concentrations (lactate/PCr)

Results

- AOD/PCr showed significantly larger anaerobic energy contribution in the 400-m trials compared to the 800-m trials
- anerobic glycolysis system contribution:
  - About 60% for 400m events
  - About 35% for 800m events.

Energy Needs: Very High Intensity Sports

- Energy needs may be adjusted according to the individual.

- **CHO**: 5-6 g/kg body wt. daily
  - Necessary to replenish glycogen stores
- **Protein**: 1.2-1.7 g/kg body wt daily
  - Necessary to help to build and maintain muscle mass, which is important for high intensity sports
- **Fat**: 1 g/kg body wt daily
  - Provides energy to support high training demands

Dietary Supplements & Ergogenic Aids

- Creatine- Most commonly used aid for for high intensity, short-duration sports
- Belief: Creatine supplementation will increase PCr stores, giving Athletes more energy
  - True or False?
    - Debatable
    - Many research studies display opposing results
    - What do you think??

Endurance Athletics

- Endurance Sports:
  - Marathon run/swim
  - Ironman & varying distance triathlon
  - long periods of time at low intensity
- Energy Systems Used:
  - Carbohydrate during warm up
  - Aerobic *B*-oxidation fat metabolism
  - <65% VO_{2max} Combination of both

Aerobioc Glycolysis

- 1 glucose Yields 38 ATP

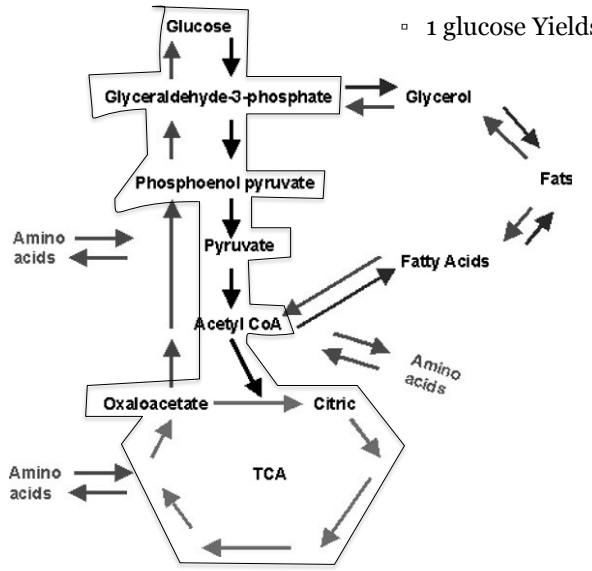


Illustration source: http://www.nature.com/pcan/journal/v9/n3/images/4500879f1.jpg

Βeta-Oxidation

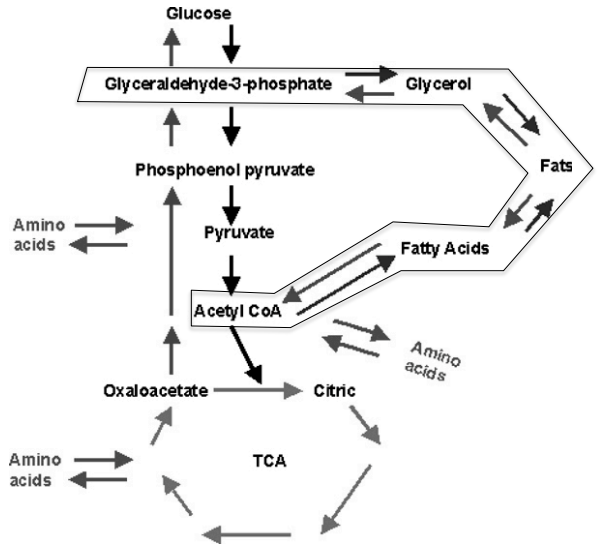
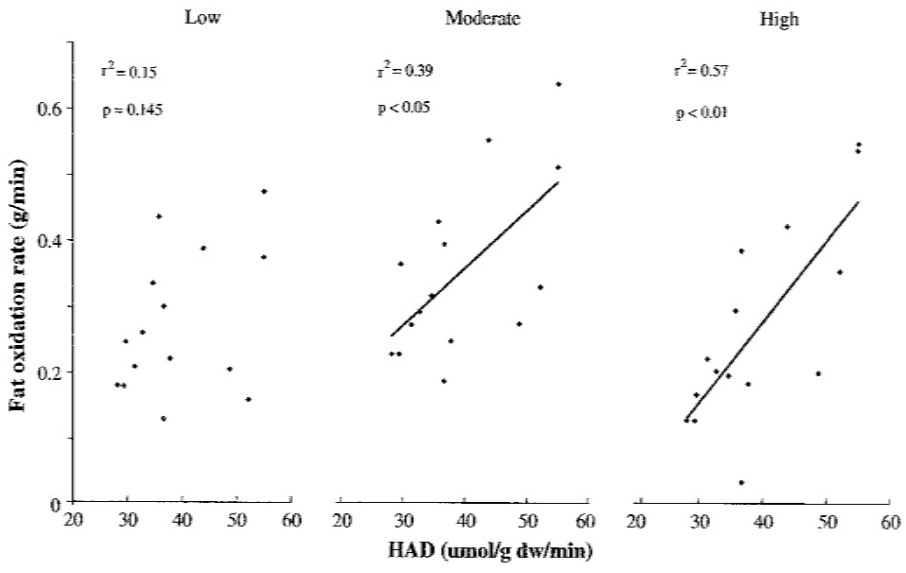


Illustration source: http://www.nature.com/pcan/journal/v9/n3/images/4500879f1.jpg

Synergy in Energy Supply

- "Intensity has a major impact on the fraction of fat oxidized." (Stisen et al 2006)
- Female fat usage study correlates energy use to all exercise intensity
- ***Maximal fat oxidation rates in endurance trained and untrained women***
- Anne Bach Stisen · Ole Stougaard · Josef Langfort · Jørn WulV Helge · Kent Sahlin · Klavs Madsen

Following Images from Stisen et al report



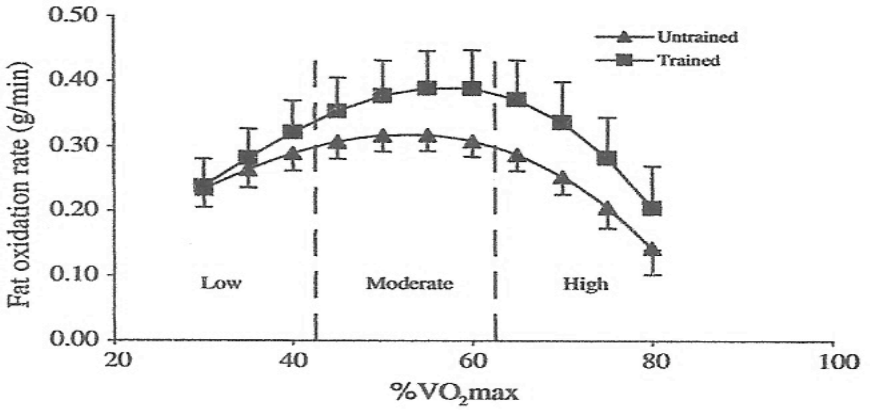


Fig. 1 Fat oxidation versus absolute power output (watt) between trained and untrained women. Values are means ± SE of nine untrained and eight trained women. *Significantly different from untrained, $P < 0.05$

Energy Needs for Endurance Athletes

- Carbohydrate
  - 7 to 10 g/kg body weight
- Protein
  - 1.2 to 2.0 g/kg body weight
- Fat
  - Increased slightly from 0.8 to 2.0 g/kg body weight

Fluid Timing

- Before
  - Drink 17 to 20 oz 2 hours before event
  - Drink 7 to 10 oz 10 to 20 minutes before event
- During
  - Drink 7 to 10 oz every 15 to 20 minutes, inc Including sodium
- After
  - Drink 20 to 24 oz sport drink every pound body weight, Including sodium

Improved Endurance Capacity Following Chocolate Milk Consumption Compared to two commercially available sport drinks

- Thomas, K., Morris, P,. Stevenson, E. (2009)

Carbohydrate and Protein + 30 min.

Intermittent Sports

Refers to activities that require shorts periods of all-out effort punctuated with periods of less intense effort.

Team Sports	Individual Sports
✓Soccer ✓Football ✓Basketball ✓Field Hockey ✓Rugby ✓Volleyball	✓Tennis ✓Squash

Varying intensities and durations tap ALL major energy systems.

Intermittent Nutrition

Macronutrients…

Carbohydrates are the preferred fuel for stop-and-go sports…

Carbohydrates

- Diets low in carbohydrates (<10% total energy from carbs) = reduced endurance time.
- Diets providing 65-84% of total energy = increased performance.
- Maughn et al noted that a high protein (particularly in conjunction with a low carb diet) resulted in metabolic acidosis- associated with fatigue.

Muscle Glycogen

- Bangsbo et al reported increasing carb content from 39-65% prior to a soccer match caused muscle glycogen levels to increase.
- This results in higher work rate and improved intermittent endurance.
- Glycogen depletion potentially contributes to fatigue, limiting the ability to maintain high intensity work output.
- Without sufficient muscle glycogen, exercise is fueled by fat. Intensity of that exercise is usually less than 50% capacity.

Blood Glucose

- May spare muscle glycogen…
- As exercise duration increases, carbs from muscle glycogen decrease and those from blood glucose increase.
- Hypoglycemia & depletion of glycogen are associated with fatigue & reduced performance.

Protein

- If amino acids are not replaced in the diet, a net loss occurs over time with losses in muscle strength and performance.
- Excessive protein intakes can lead to health hazards.
- There is a lack of evidence to show that an addition of protein increases performance.

Fat

- Plays the smallest role in energy distribution.
- Fat should contribute to 30% or less of total energy.
- Athletes often consume levels of fat to support weight and weight training goals, but this consumption should be limited.

Fluids

- Major causes in fatigue are due to thermoregulation and fluid loss.
- Repletion of muscle glycogen also relies on fluid intake- each gram is stored with 2.7 grams of water.
- Full rehydration after exercise is best achieved when replacement fluid contains sufficient sodium and is consumed at 150% of fluid lost during exercise. (Shirreffs et al)

Study: Carbohydrate Availability and Muscle Energy Metabolism during Intermittent Running

Purpose: To investigate the effects of ingesting a CHO-E solution on performance and muscle glycogen use during prolonged intermittent high intensity running to fatigue in carbohydrate-loaded men.

Andrew Foskett, Clyde Williams, Leslie Boobis, and Kostas Tsintzas (2007) *Medicine and Science in Sports and Exercise*

Results

- All subjects ran longer during the CHO-E trial compared with the PLA trial by 21%.
- Study shows for the first time CHO-E during exercise leads to an improvement in high intensity intermittent running capacity, but did not affect muscle glycogen use.
- Subjects with high pre-exercise muscle glycogen as a result of dietary CHO loading, the solution of 6.4% CHO-E used immediately before and during exercise can increase endurance capacity.

Weight & Body-focused Sports

Examples of Sport Activities:

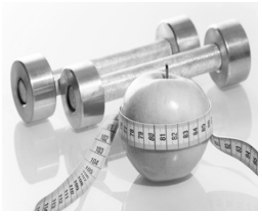
- figure skating
- gymnastics
- Wresting

Energy Systems

- Adenosine triphosphate - creatine phosphate energy system (ATP-PC) 70%-90%
  - high-intensity muscular work
- Aerobic Glycolysis System 10%-30%
  - quick recovery
  - low-to medium-intensity activity

Energy needs

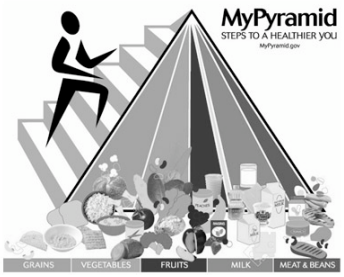
for weight & body focused sports



- **Carbohydrate**
  - primary fuel of athletes
    5 to 8 g/kg body weight, daily
- **Protein**
  - stimulate muscle protein synthesis
  - promote performance
    1.2 to 1.7g/kg body weight, daily
- **Fat**
  - individual nutritional demand
  - for the various normal physiological functions
    20% to 35% is recomended

Meal-Planning Recommendations

- **Before the event**
  - high in carbohydrate low in protein & fat foods
- **Between event**
  - water or sport drink
  - easily digestible carbohydrate foods
- **After the event**
  - sport drinks
  - fruit juices
  - carbohydrate-containing fluids



Study: Cereal and nonfat milk support muscle recovery following exercise

Kammer, L., Ding, Z., Wang, B., Daiske, H., Liao, Y., & Ivy, J. L. (2009). Cereal and nonfat milk support muscle recovery following exercise. *Journal of the International Society of Sports Nutrition. 6*(11). Retrieved September 26, 2009, from PubMed Central.

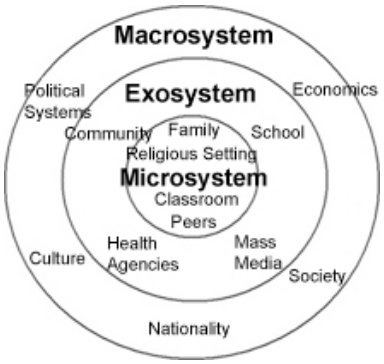
Recovery

- Within the first 30 minutes
- Carbohydrate and Protein in a ratio:
  3 -4 to 1

Similar to Chocolate milk!!!

Human Ecological Model

- **Microsystem**: Athletes influenced by coaches, family, and friends
- **Exosystem**: Athletes influenced by the community, the school that the athlete is representing, and media within the community
- **Macrosystem**: Athletes affected by rules and regulations, politics, culture, and the society as a whole



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